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TITLE: INJECTION DEVICE

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SAFETY INJECTION DEVICE FOR A LIQUID OR SEMI-SOLID COMPOSITION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Patent Application 09/110,773, filed July 6, 1998, which issued as U.S. Patent 6,213,983 on April 10, 2001, which is a continuation of U.S. Patent Application 08/777,634, filed December 31, 1996, which issued as U.S. Patent 5,776,107 on July 7, 1998, the contents of each of which is incorporated herein in its entirety.

BACKGROUND OF THE INVENTION

The invention relates to a device for the parenteral administration through a needle of liquid or semi-solid drug compositions wherein the needle is protected before and after the injection.

The parenteral introduction of pharmaceutically active compounds is preferred over oral dosage for many indications, e.g. where the drug to be administered would partially or totally degrade in the gastrointestinal tract or where there is need for rapid biological response. The need for extratemporaneous preparation of such parenteral compositions is eliminated, or simplified, by the use of pre-filled administration devices in which the liquid to be injected is pre-loaded into the device (e.g. a pre-loaded syringe). Such pre-loaded devices, however, have a number of drawbacks, including the inability to preserve the asepsis or sterility of the needle, as well as the general danger of using an exposed needle. To eliminate these drawbacks, it is necessary to avoid the direct exposure of the needle with the environment both prior to and following injection.

SUMMARY OF THE INVENTION

The invention features a comparatively inexpensive injection device with a needle for parenteral injection of liquid or semi-solid drug compositions into a subject, e.g. a mammal such as a human, wherein the needle is protected before and after the injection.

In general, the invention features an injection device including a housing, the housing having proximal and distal ends and designed to contain a liquid or semi-solid drug composition; a hollow needle, the needle affixed to the distal end of the housing and extending longitudinally within the housing; a plunger, the plunger arranged to slide within the proximal end of the housing; and a hollow sleeve, the hollow sleeve arranged to cover

the needle prior to injection and to retract into the housing during injection; wherein the device is designed such that when the sleeve is pressed against the subject, the sleeve retracts into the housing and the drug composition is delivered through the needle and into the subject.

- 5 In one embodiment, the device is further designed such that when the drug composition is forced from the housing, the plunger forces the sleeve out of the housing to cover the needle. In a further embodiment, the housing contains the liquid or semi-solid drug composition.

- 10 In another embodiment, the device further comprises a septum plunger, the septum plunger slidably arranged within the housing between the plunger and the distal end of the housing. In a further embodiment, the device is configured such that when the drug composition is forced from the housing, the plunger forces the septum plunger into the sleeve, and the septum plunger forces the sleeve out of the housing to cover the needle. In still a further embodiment, the housing contains the liquid or semi-solid drug composition
15 between the plunger and the septum plunger.

In still another embodiment, the housing contains a liquid and a dry drug composition, where the device is designed to combine the liquid and the dry drug composition prior to injection.

- 20 In a further embodiment the device comprises a releasable lock which inhibits the movement of the plunger into the housing. In a still further embodiment the device comprises a removable cap which covers the sleeve. In yet a still further embodiment the proximal end of the housing comprises a flange and/or the plunger comprises a flange.

- 25 An optional feature of the device comprises a cartridge or tube, said cartridge or tube comprising a distal end, said distal end closed by a cap, seal or septum; a proximal end, said proximal end closed by a plunger tip slidably arranged within the cartridge or tube; and a reservoir between said cap, seal or septum and said plunger tip.

- Optionally said cap, seal or septum may be attached to said distal end with a classical clip means, e.g., using a metal ring. The cap, seal or septum and the plunger tip each is made of a suitable material, i.e., a material compatible with the intended use of the injection
30 device. In a preferred embodiment the cap, seal or septum and the plunger tip each independently is made of a non-rigid solid material such as rubber, polybromobutyl, or the

like. In a more preferred embodiment the cap, seal or septum and the plunger tip each is made of the same material.

5 The cartridge or tube is configured to contain a liquid or semi-solid drug composition within the reservoir and is introduced into the housing of the device, e.g., through the proximal end of the housing. The cartridge or tube is further configured such that it can be moved within the housing, e.g., toward or away from the proximal end of the needle. Said cartridge or tube is optionally of a standard variety.

10 The injection device is configured such that, after the cartridge or tube is connected to the proximal end of the needle, i.e., after the proximal end of the needle pierces the cap, seal or septum located at the distal end of the cartridge or tube, then when the sleeve is pressed against the subject the sleeve retracts into the housing thereby exposing the distal end of the needle and allowing the distal end of the needle to penetrate the subject. Thereafter, when the plunger tip at the proximal end of the cartridge or tube is urged into the cartridge or tube, i.e., toward the distal end of the cartridge or tube, the drug composition
15 is urged from the cartridge or tube through the needle and into the subject.

20 According to a particular variant of this invention, the cartridge or tube further comprises a proximal compartment located toward the proximal end of the cartridge or tube and a distal compartment located toward the distal end of the cartridge or tube, wherein the proximal compartment and the distal compartment are separated by a plunger. In this variant said proximal compartment contains a liquid component of a composition and the distal compartment contains a solid component of said composition. In this variant the device is configured such that, in operation, the liquid and solid components are mixed prior to injection.

25 In one embodiment, the device is further configured such that when the drug composition is forced from the cartridge or tube, the cartridge or tube urges the sleeve out of the housing thereby covering the needle after the injection and, optionally, urging the withdrawal of the needle from the subject. In a further embodiment, the cartridge or tube contains the liquid or semi-solid drug composition.

30 In another embodiment, the cartridge or tube further comprises a septum cap or seal to close the distal end and a septum plunger to close the proximal end of the tube. Said septum cap or seal is fixed by a clip and said septum plunger is slidably arranged within the cartridge or tube. In a further embodiment, the device is configured such that, when the

cartridge or tube is urged sufficiently into the housing the proximal end of the needle passes through the septum cap or seal, and, when the drug composition is urged from the cartridge or tube by the septum plunger, said septum plunger urges the cartridge or tube and the cartridge or tube urges the sleeve out of the housing to cover the needle. In still a
5 further embodiment, the cartridge or tube contains the liquid or semi-solid drug composition between the septum cap or seal and the septum plunger.

In still another embodiment, the cartridge or tube contains a liquid and a dry drug composition, where the device is designed to combine the liquid and the dry drug composition prior to injection.

10 The device can further include a cartridge or tube locking means to inhibit the movement of the cartridge or tube in the housing, e.g., after the cartridge or tube has been connected to the needle. The proximal end of the housing may have a flange and the plunger may also have a flange.

In still another embodiment of the injection device the housing comprises the reservoir and
15 the hollow needle is affixed to the distal end of the reservoir and extends only longitudinally outside said reservoir. A housing or protection sleeve is configured on the plunger and is arranged to slide around the reservoir. The device is configured such that when the drug composition is urged from the reservoir, the plunger housing covers said reservoir. At the end of the injection the plunger is released from the plunger housing, e.g.,
20 by the proximal end of the reservoir, and the plunger slides into said plunger housing thereby allowing the plunger housing to cover the needle.

A further object of the invention is therefore an injection device for injecting liquid or semisolid composition into a subject, the device comprising: a reservoir having a proximal and distal end, said distal end being configured to contain a liquid or semi-solid
25 composition; a hollow needle, said needle affixed to the distal end of the reservoir and extending longitudinally outside said reservoir; a plunger arranged to slide within the proximal end of the reservoir; said plunger arranged to retract after injection into a plunger housing slidably connected to the proximal end of the reservoir and arranged to cover the plunger, the reservoir and the needle after injection; wherein the device is
30 designed such that when the plunger housing is pushed around the reservoir, the plunger is pushed into the reservoir, the composition is pushed from the reservoir through the needle and into the subject.

According to a preferred execution mode of this injection device, said plunger housing is disconnected from said plunger due to a release mechanism into said proximal end of the reservoir. According to another preferred execution mode, the protection sleeve is designed to be locked in an irreversible manner by, e.g., mechanical means once the needle
5 has been protected.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the
10 preferred methods and materials are described below. All publications, patents, patent applications, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

15 Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross-sectional view of an injection device prior to use.

FIG. 2 is a partial cross-sectional view of the injection device of FIG. 1 during use.

FIG. 3 is a partial cross-sectional view of the device with the needle injected into a
20 subject.

FIG. 4 is a partial cross-sectional view of the injection device being withdrawn from the subject with the drug composition remaining in the subject.

FIG. 5 is a partial cross-sectional view of the injection device following complete withdrawal of the needle from the subject.

25 FIG. 6 is a partial cross-sectional view of the injection device through line 6-6 in FIG. 1.

FIG. 7 is a view of the sleeve of the injection device.

FIG. 8 is a partial cross-sectional view of a cartridge injection device prior to pre-introduction of the cartridge.

FIG. 9 is a partial cross-sectional view of a cartridge injection device prior to use.

FIG. 10 is a cross-sectional view of the cartridge injection device of FIG. 9 during use
5 after connection of the cartridge to the needle.

FIG. 11 is a partial cross-sectional view of the cartridge injection device of FIG. 10 during use after plunger setting.

FIG. 12 is a cross-sectional view of the cartridge injection device with the needle injected into a subject.

10 FIG. 13 is a partial cross-sectional view of the cartridge injection device being withdrawn from the subject with a drug composition remaining in the subject.

FIG. 14 is a partial cross-sectional view of the cartridge injection device following complete withdrawal of the needle from the subject.

FIG. 15 is a cross-section of the injection device through line 6-6 in FIG. 8.

15 FIG. 16 is a cross-section of a cartridge containing a liquid or semi-solid composition.

FIG. 17 is a cross-section of a cartridge containing a liquid and a dry drug:

- 17A: prior to rehydration;
- 17B: after rehydration.

20 FIG. 18 is a cross-section of the housing with the two options or the cartridge (right) and the tube (left).

FIG. 19 is a cross-section of the tube containing a liquid and a dry drug before and after rehydration.

FIG. 20 is a cross-section view at the stage of FIG. 10 in a case where tube containing a liquid and a dry drug before and after rehydration.

25 FIG 21 is a cross-section view of a reservoir injection device prior to use.

FIG 22 is a cross-sectional view of the reservoir injection device after drug composition injection.

FIG 23 is a cross-sectional view of the reservoir injection device following complete withdrawal of the needle from the subject.

DETAILED DESCRIPTION

5 It is believed that one skilled in the art can, based on the description used herein, utilize the present invention to its fullest extent. The following specific embodiments are, therefore, to be construed as merely illustrative, and not limiting.

FIG. 1 shows injection device 1 including housing 10, having a proximal end and a distal end 14a, 14b. The distal end of the housing 10 has two holes 40a and 40b partially
10 separating the two parts 14a and 14b of said distal end (as best seen in FIG. 6). Needle 12 is attached to part 14a of the distal end. The housing 10 can be made from a suitably rigid material such as glass, plastic, metal, and the like. The needle 12 is hollow and double-ended, wherein its distal end, remaining outside housing 10, has a point capable of piercing the skin of a subject, and its proximal end, remaining within housing 10, is capable of
15 piercing septum plunger 16. On the proximal end of housing 10 is a flange 28 to assist in removal of device 1 from the subject following injection.

A sleeve 22 surrounds needle 12 so that needle 12 is not fully exposed to the environment until used. Sleeve 22 has longitudinal slots 45a and 45b along its length (see FIG. 7; slot 45b is on the back of the sleeve and is thus not shown). The two parts 14a and 14b of the
20 distal end are joined by radially extending connecting members 42a and 42b (see FIG. 6). Connecting members 42a and 42b, respectively, slide through slots 45a and 45b in sleeve 22, while sleeve 22 slides through holes 40a and 40b in housing 10. Sleeve 22 can be made of suitably rigid material, such as metal, glass, plastic, and the like. Seal 24 covers the opening 23 of sleeve 22 to maintain the sterility of needle 12 and prevent sleeve 22
25 from unintentionally retracting into housing 10 through holes 40a and 40b prior to injection.

Seal 24 can be made of a thin material, such as plastic or wax, which is easily penetrated by needle 12 during injection. A similar seal can also cover slots 45a and 45b in sleeve 22, to further protect the sterility of needle 12.

Septum plunger 16, contained within housing 10, includes a bore 26, in which needle 12 rests prior to subsequently piercing septum plunger 16. A liquid or semi-solid composition 20 is isolated in housing 10 between the septum plunger 16 and the plunger tip 30, attached to plunger 29. Septum plunger 16 and plunger tip 30 may be made of non-rigid, solid material such as rubber, polybromobutyl, and the like, which allows septum plunger 16 and plunger tip 30 to slide within housing 10 but still maintain sufficient friction with the inner sides of housing 10 to seal composition 20 within housing 10.

The proximal end of plunger 29 has a thumb flange 18 to assist in the depression of plunger 29 into housing 10, and the distal end of plunger 29 has a longitudinal bore 27 to receive needle 12 following injection of composition 20 out and through needle 12. Plunger 29 can be made from a suitably rigid material, such as glass, metal, plastic, and the like. A removable lock 25 may be placed between flange 18 and flange 28 to inhibit further depression of plunger 29 into housing 10 after activation of the device 1, i.e. after the housing 10 is filled with a drug composition and the proximal end of the needle is pierced through septum plunger 16. A removable cap 21 can also be used to protect both needle 12 and sleeve 22 prior to use. Both cap 21 and lock 25 can be made from suitably rigid material such as plastic, metal, rubber, and the like.

FIG. 2 shows device 1 wherein plunger 29 has been pressed into housing 10 to activate device 1 as follows. When plunger 29 is depressed, plunger tip 30, composition 20, and septum plunger 16 are displaced towards the distal end of housing 10. Septum plunger 16 is pierced at bore 26 by needle 12. As a result, the proximal end of needle 12 is exposed to composition 20. Device 1 is now in an activated state. Lock 25, by contacting both flange 18 and flange 28, inhibits the further displacement of composition 20 from housing 10 to needle 12 following activation of device 1, i.e. composition 20 is allowed to fill needle 12, but lock 25 inhibits significant release of composition 20 through needle 12.

FIG. 3 shows device 1 wherein needle 12 has penetrated skin 32 of the subject being treated. As device 1 is pressed against skin 32, sleeve 22 is retracted into housing 10, through holes 40a and 40b, by the force of pressure against skin 32. Needle 12 passes through sleeve 22 at opening 23. As shown, needle 12 has penetrated through skin 32 into the subcutaneous layer 34.

FIG. 4 shows device 1 wherein lock 25 has been removed and plunger 29 has been depressed, which moves plunger tip 30 toward septum plunger 16, thereby injecting

composition 20 into subcutaneous layer 34 through needle 12. Once composition 20 has been injected and plunger tip 30 rests against septum plunger 16, housing 10 is moved away from skin 32 by exerting pressure against the lower part of the flange 28 while simultaneously exerting opposing pressure on flange 18 of plunger 29. This relative movement of the plunger 29 and housing 10 causes plunger tip 30 to force septum plunger 16 against sleeve 22 as both plunger tip 30 and septum plunger 16 slide towards parts 14a and 14b of the distal end of housing 10, which in turn forces sleeve 22 out of housing 10 through holes 40a and 40b. As plunger tip 30 and septum plunger 16 are moved toward distal end of housing 10, needle 12 penetrates septum plunger 16, plunger tip 30, and enters bore 27 in plunger 29.

FIG. 5 shows needle 12 fully withdrawn from skin 32 and sleeve 22 fully covering needle 12. Composition 20 remains in the subcutaneous layer of the patient. As can also be seen in FIG. 5, the proximal end of needle 12 has been pushed through septum plunger 16 and plunger tip 30 and remains in bore 27 of plunger 29.

FIG. 6 is a cross-sectional view of FIG. 1 at 6-6. FIG. 6 shows holes 40a and 40b in housing 10. Radially extending connecting members 42a and 42b extend through slots 45a and 45b, respectively, to connect parts 14a and 14b of the distal end. Needle 12 is fixed to central part 14a of the distal end, and sleeve 22 can slide through holes 40a and 40b.

FIG. 7 shows an isolated sleeve 22 having slots 45a and 45b (45b is not shown but positioned directly opposite to slot 45a on the other side of sleeve 22) and opening 23. Radially extending connecting members 42a and 42b, respectively, slide through slots 45a and 45b.

FIG. 8 shows a cartridge injection device 1 including a housing 10 having a proximal and a distal end.

The distal end of housing 10 has at least one hole and for example two holes, 40a and 40b, partially separating the two parts of the distal end (as best seen in FIG. 15). Needle 12 is attached to the distal end. The housing 10 can be made from a suitably rigid material such as glass, plastic, metal, and the like. The needle 12 is hollow and double-ended, wherein its distal end, remaining outside housing 10, has a point capable of piercing the skin of a subject, and its proximal end remaining within housing 10 is capable of piercing septum cap 17 and septum plunger 30 of the cartridge or tube 11. On the proximal end of housing

10 is a flange **28** to assist in injection. The removal of device **1** from the subject following injection is assisted by extension of sleeve **22**.

5 A sleeve **22** surrounds needle **12** so that needle **12** is not fully exposed to the environment until used. Sleeve **22** has at least one longitudinal slot along its length, and for example two, **45a** and **45b** (see FIG. **15**). The two parts of the distal end are joined by radially extending connecting members **42a** and **42b** (see FIG. **15**). Connecting members **42a** and **42b** respectively slide through slots **45a** and **45b** in sleeve **22**, while sleeve **22** slides through holes **40a** and **40b** in housing **10**. Sleeve **22** can be made of suitably rigid material such as glass, plastic, metal and the like.

10 A seal **24** (not shown) on needle **12** can be made of a thin material, such as a plastic sheet, a plastic packaging material or a bag which is easily penetrated by needle **12** during injection. A similar seal can also cover the sleeve **22** to further protect the sterility of the needle **12**.

15 Septum plunger **16**, contained within housing **10**, can include a bore **26** in which needle **12** rests prior to subsequently piercing septum plunger **16**. A liquid or semi-solid composition **20** is isolated in the cartridge **11** between septum plunger **16** and plunger tip **30**. Septum plunger **16** and plunger tip **30** may be made of non-rigid solid material such as rubber, polybromobutyl, or the like, which allows plunger tip **30** to slide within cartridge **11** but maintaining sufficient friction with the inner sides of the cartridge **11** to seal composition **20** within cartridge **11**.

20 The proximal end of plunger **29** has a thumb flange **18** to assist in the depression of plunger **29** into cartridge **11** and the distal end of plunger **29** has a longitudinal bore **27** to receive needle **12** following injection of composition **20** out and through needle **12** (see FIG. **11**). Plunger **29** can be made from a suitably rigid material such as glass, plastic, metal and the like. A removable lock **25** may be placed between flange **18** and flange **28** to inhibit the further depression of plunger **29** into housing **10** after activation of device **1**, i.e. after the housing **10** is filled with a tube or a cartridge and the proximal end of the needle is pierced through septum cap **17**.

25 A removable cap **21** can also be used to protect both needle **12** and sleeve **22** prior to use. Both cap **21** and lock **25** can be made from suitably rigid material such as plastic, metal, rubber, and the like

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Septum cap 17 on distal end of cartridge 11 is sealed, e.g., with a metal ring (not shown). A liquid or semi-solid composition 20 is isolated in cartridge or tube 11 between the septum cap 17 and the plunger tip 30, which will be attached to plunger 29 (see FIG. 11). The cartridge or tube 11 can be connected to the proximal end of needle 12 by applying
5 pressure to the proximal end of the cartridge or tube, e.g., by pushing with the thumb (see FIG. 10).

Septum cap 17 and plunger tip 30 may be made of non-rigid material such as rubber, polybromobutyl, and the like, which allows needle 12 to pierce septum cap 17 and plunger tip 30, and allows plunger tip 30 to slide sealably within cartridge or tube 11.

10 FIG. 9 shows, during use of device 1, the introduction of cartridge or tube 11 into the housing 10.

FIG. 10 shows the connection of cartridge or tube 11 on needle 12 through septum cap 17.

FIG. 11 shows settlement of plunger 29 on plunger tip 30.

15 FIG. 12 shows injection of needle 12 with retraction of sleeve 22 into housing 10.

FIG. 13 shows injection of composition 20 into the tissue, e.g., using thumb on plunger flange 18 and the other fingers on housing flange 28.

FIG. 14 shows removal of the device from the subject following injection, where cartridge or tube 11 urges sleeve 22 from housing 10 around needle 12 and, consequently, removes
20 needle 12 from body tissue.

FIG. 15 shows a cross-section, through line 6-6 shown in FIG. 8, of distal end 14b of housing 10 with two apertures or holes 40a and 40b through which slots 45a and 45b of sleeve 22 slide. Two connecting members 42a and 42b separate the holes and connect external part of the housing 10 with the internal part where needle 12 is fixed.

25 FIG. 16 shows a cartridge or tube 11 used in the housing 10 of device 1 with composition 20 between septum cap 17 and plunger tip 30.

FIG. 17A shows a cartridge or tube 11 used in the housing 10 of device 1 with a releasable lock 50. The liquid part of the composition 20B is loaded in cartridge or tube

11 between two septum plunger **30A** and septum plunger **30B**. Septum plunger **30A** is placed into cartridge or tube **11** just before by-pass **51**. Septum plunger **30B** is locked with the lock **50** in contact with cartridge or tube **11**. The solid part of the composition **20A** is loaded, e.g., under vacuum, in cartridge or tube **11** between septum plunger **30A** and septum cap **17**.

FIG. **17B** shows cartridge or tube **11** of FIG. **17A** after removal of the releasable lock **50**. The composition **20** is prepared by passage of the liquid part of the composition **20B** through the by-pass **51** into the solid part under vacuum.

FIG. **18** shows device **1** with the tube option **11A** or the cartridge option **11B** presented with the dual chamber arrangement of FIG. **17**. The housing **10** can be the same for both options (**11A** or **11B**). Before removal of releasable lock **50**, tube **11A** or cartridge **11B** cannot be connected on needle **12** through septum cap **17**. After removal of releasable lock **50**, the rehydration is realized as described in FIG. **17** or FIG. **19** and tube **11A** or cartridge **11B** can be operably connected to needle **12**. The plunger **29** is attached to septum plunger **30B** and the injection is performed.

FIG. **19** shows, for tube **11A**, the rehydration process described in FIG. **17**, performed by removing lock **50**. Before removing lock **50** on FIG. **12A**, tube **11A** cannot be introduced into the housing deep enough to introduce needle **12** through septum cap **17** into the tube **11A**. Releasable lock **50** also maintains plunger **30A** at the top of by-pass **51** despite the vacuum in the solid part of the composition **20A**. After removing lock **50** on FIG. **12B**, tube **11A** can be introduced into the housing to introduce needle **12** through septum cap **17** into the tube **11A**. Before this introduction by removing lock **50**, the composition **20** is prepared by mixing the solid part **20A** and the liquid part **20B** due to the rehydration obtained by the vacuum of the chamber containing solid part **20A**.

FIG. **20** shows 2 possible variations in the arrangement of FIG. **8** during use after connection of the cartridge or tube **11** on the needle **12** when the needle **12** is not directly attached to the distal end of housing **10** but to a support **50** which corresponds to distal end of housing **10** in the way sleeve **22** is affixed to it.

This independent support **50** can be connected to housing **10**, e.g., like a pen or cartridge disposable needle is connected, e.g., by screwing onto housing **10** after needle **12** is introduced through septum cap **17**.

In FIG. 20A, the removal of the device from the subject following injection is obtained by sleeve 22 as in FIG. 8 due to the displacement of cartridge or tube 11.

FIG. 20B shows another alternative where the extension of sleeve 22 after injection is facilitated by spring 51 without displacement of cartridge or tube 11. This allows the thread to be a standard one and the device to be adapted on any other existing cartridge pen or syringe injector.

FIG. 21 shows injection device 1, including reservoir 10, having a distal end 14a and a proximal end 14b. The proximal end of the reservoir 10 has two holes 40a and 40b adapted to operatively accept arms 22a and 22b. Needle 12 is operatively attached to distal end 14a. Reservoir 10 can be made from a suitably rigid material such as glass, plastic, metal, or the like. The needle 12 is hollow and single-ended outside the reservoir 10 with a tip capable of piercing the skin of a subject. On the proximal end of housing is a flange 28 having, e.g., an elliptic shape, which assists both plunger movement in the reservoir and removal of device 1 from the subject via extension of sleeve 22 following injection.

In this embodiment the sleeve 22 comprises a plunger housing made of a suitably rigid material such as metal, glass, plastic, or the like. The plunger housing 22 surrounds plunger 29 so that when plunger 29 slides into reservoir 10, plunger housing 22 slides around reservoir 10. Plunger housing 22 has longitudinal slots (not shown) and arms 22a and 22b along its length. Arms 22a and 22b pass through holes 40a and 40b respectively in the proximal end 14b.

The proximal end of plunger 29 is covered by plunger housing 22 up to a flange 18. Flange 18 assists depression of plunger 29 into reservoir 10 along with simultaneous depression of plunger housing 22 around reservoir 10 due to the removable lock 17 or connection means with plunger 29 into plunger housing 22.

FIG. 22 shows device 1 as depicted in FIG. 21 wherein plunger 29 has been depressed by plunger housing 22 thereby injecting composition from reservoir 10 through needle 12.

Once composition has been injected plunger 29 rests against the bottom or distal end of reservoir 10, which is also completely covered by plunger housing 22.

Reservoir **10** is then moved away from the injection needle site by exerting pressure against the lower part of the flange on proximal end **14b** of the reservoir **10** while simultaneously exerting opposing pressure on flange **18** of plunger housing **22**. This relative movement of the plunger housing **22** and reservoir **10** causes plunger **29** to be released from removable lock **16** due to sliding guide and release mechanism on reservoir proximal end **14b**, and plunger housing slides around reservoir **10** and needle **12**, which in turn urges needle **12** out of injection site.

FIG. **23** shows needle **12** fully withdrawn from the injection site and plunger housing **22** covering reservoir **10** and needle **12**.

Flange **18** is equipped with means **46** to secure, optionally irreversibly, the plunger housing **22** once the needle **12** has been protected.

Composition **20** is a liquid or a semi-solid composition containing a drug. The drug of composition **20** can be any drug capable of being parenterally administered as a liquid or a semi-solid. For example, the drug can be a vaccine, a peptide, a protein, or a small chemical entity. Examples of suitable drugs include, e.g., insulin and heparin. For drugs which are not stable in liquids over an extended period of time, the liquid and the dry drug can be stored in separate chambers within housing **10**. The device can be configured such that the liquid and the dry drug are combined together just prior to injection.

For example, the chamber created between septum plunger **16** and plunger tip **30** (e.g. in FIG. **1**) in housing **10** can be separated into two separate parts by a fixed wall or film that can be punctured, e.g. by pressure of the plunger **29** on the plunger tip **30**, or a puncturing means. Alternatively, the two parts of the chamber can be separated by a moving wall or septum. In this case, the top or proximal part of the chamber above the moving wall or septum contains the liquid portion of the composition, and the distal part of the chamber contains the solid, e.g., powder, portion of the composition. When plunger **29** is urged into housing **10**, it applies pressure to plunger tip **30** and plunger tip **30** applies pressure to the liquid portion of the composition. This, in turn, applies pressure on the moving septum, causing it to move in a distal direction. The housing is configured with a liquid bypass (e.g., a bulge or passage in the housing wall) in a location that initially prevents passage of liquid from one part of the chamber to the other, but when the moving septum reaches a specific location, the bypass allows the liquid to pass from the top or proximal

part of the chamber into the lower or distal part of the chamber on the other side of the moving septum.

To maintain sterility, the device of the invention can be stored in a conventional blister pack or pouch prior to use.

OTHER EMBODIMENTS

It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the appended claims. Other aspects, advantages, and modifications are within the claims.

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000